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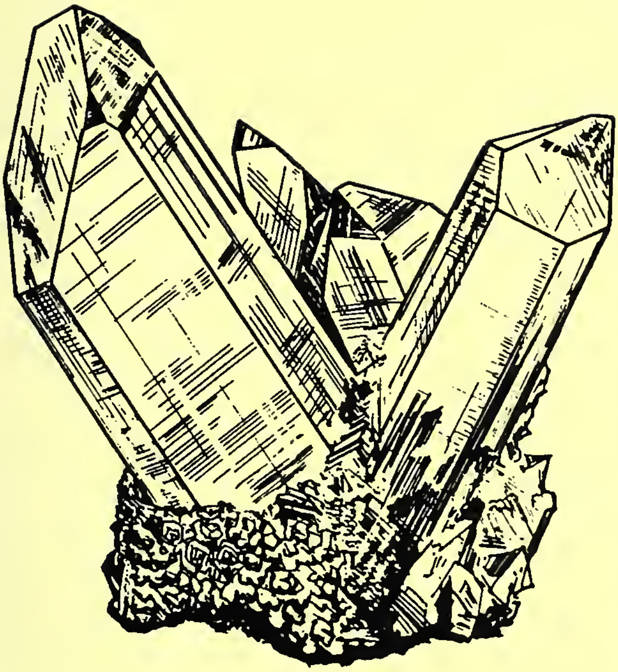

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COMMON ROCKS AND MINERALS OF PENNSYLVANIA

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ARTHUR A. SOCOLOW, *State Geologist*

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COMMON ROCKS and MINERALS of PENNSYLVANIA

by
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MINERAL COLLECTING

Always Ask Permission To Collect!

The surface of the earth is made up of rocks which contain more than 2,000 different kinds of minerals. Many of these are rarely seen because they are buried deep within the earth. The varying hardness of these rocks and minerals is responsible, in part, for Pennsylvania's varied landscapes. Mountain ridges are held up by rock formations composed of hard, resistant minerals; valleys and lowlands exist where the minerals in the rocks are easily broken down and washed away. This does not mean that all mountains contain the same minerals because there are many varieties of hard and soft minerals, and also because some minerals which are durable in one climate are easily decomposed in another. The soils which support all vegetation are composed of mineral fragments weathered from once-solid rock. These mineral fragments and the kinds of mineral in the hard rock beneath the soil cover determine the thickness and richness of the soil.

The world of man-made articles depends on the elements obtainable from minerals. For example, both the cheapest bottle glass and the most expensive camera lens are made of the elements silicon and oxygen combined in the mineral quartz. The metals of cars, steel-girdered buildings, and manufacturing machinery are obtained only through the efforts of men exploring, sampling, testing, and finally mining or quarrying in order to extract metal-bearing ores from otherwise useless rock. Every step of our modern existence is aided by a knowledge and development of our mineral resources. New mineral deposits are constantly being sought and new uses of common minerals are being discovered every day.

As gems, minerals have captured imaginations from the earliest civilization down to the present time. Man, even in his attempt to reproduce gem stones, has hardly scratched the surface when compared to the variety and beauty of nature's own minerals.

The joys of finding minerals of unusual shape, color, or variety have made mineral collecting a common hobby. Minerals are within walking distance of nearly everyone. Thanks to nature's generosity the cost of collecting them is nothing more than a little time and perhaps some gasoline. Many minerals remain waiting to be discovered; the collector has an opportunity to be the first human being to see that particular crystal; perhaps even to discover a rare specimen. He is an explorer into a frontier of almost limitless extent.

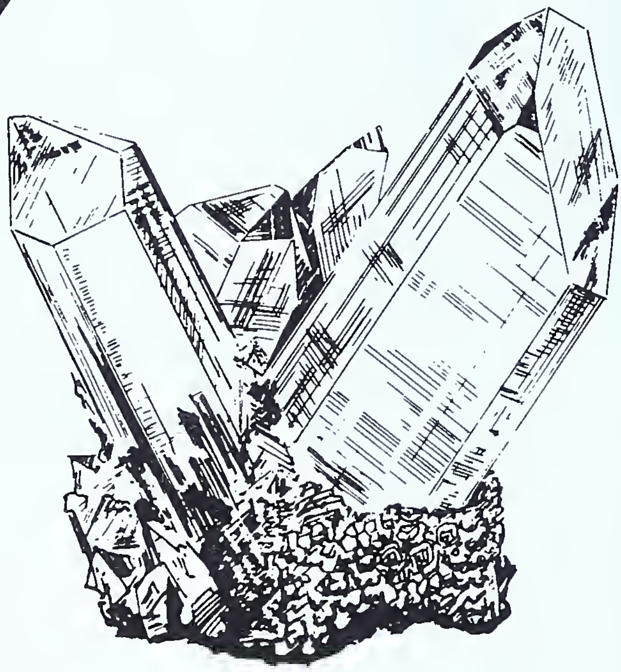
Like minerals, rocks also tell an exciting story. They are an adventure into the early history of the Earth. As far back as a billion years ago some of the rocks formed which we see today on the surface. Those in Chester County are an example. Northwestward across Pennsylvania from Chester County toward Lake Erie the rocks gradually become younger, but the youngest rocks are still pretty old; about 190 million years! Most of these rocks represent an old sea bottom that has since been raised above the level of the sea. Some, however, were once fresh water lakes and are now certain kinds of limestones or sandstones. Channels of old river beds can sometimes be seen in the sandstones of Pennsylvania. Red, sandy rocks tell us that here was once an old shoreline along some sea or lake which disappeared hundreds of millions of years ago. Other rocks tell us where old mountains once towered above the land, although they may be no more than rolling hills today. These are the metamorphic rocks such as schist and gneiss. Other kinds are evidence of a once molten rock which moved upward toward the surface from several miles below. These are called igneous rocks. Granite is a good example. All in all, rocks have a long and fascinating story hidden within them, and it is a challenging story which can be fun to try to unravel.

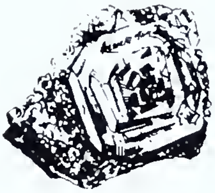
Pennsylvania Geological Survey
Common Rocks & Minerals of Pennsylvania

The information in this booklet should serve as a challenge to the vast knowledge and pleasure which may be obtained from a more thorough study of rocks and minerals. You may even wish to experiment with crystal-growing in your own home. Additional information and a description of selected collecting localities may be found in the Pennsylvania Geological Survey's Bulletin G-33, "Mineral Collecting in Pennsylvania."

Nature grows its own minerals in limestone caves.

MINERALS





A **MINERAL** is a substance which has a fairly definite chemical composition and which occurs in definite shapes called crystals. Crystals are characterized by surfaces, called faces, and may either form perfectly or be distorted into unusual shapes. Regardless of its external form, a crystal always has an orderly internal arrangement of atoms. The ratios in which these atoms occur in any mineral are expressed as a chemical formula. The formula tells which elements are contained in the mineral. For example, quartz has the formula SiO_2 which tells us that quartz is made up of silicon (Si) and oxygen (O) and that there are two oxygen atoms for every silicon atom. Minor amounts of other elements are commonly present as impurities.

Some of the minerals we find today may have been formed billions of years ago, long before any form of life existed on our planet. Others may have formed almost as recently as yesterday. Some rocks and minerals form in a matter of a few hours; others may require many years. Malachite, the green copper carbonate, is an example of a mineral that forms rapidly. Look closely at the next bronze statue or plaque you see. It will probably have some malachite on it which comes from the copper in the bronze. On the other hand, large crystals of quartz which sometimes grow to several feet in length may require years to completely crystallize.

Besides time, there are many other things which control the growth of a crystal. Temperature is the most important. Certain minerals, like chromite, only form at very high temperatures; others, like malachite, only at low temperatures. The pressure on the mineral as it is growing is another important factor in the rate of mineral formation. For example, a mineral such as diamond will crystallize only under very high pressures. In addition to these two, temperature and pressure, the right elements have to be available in the right amounts. All of these conditions together make crystal growing a complicated process.

Minerals are usually classified in two different ways: by their chemical composition, or by the way in which they grow. The mineral descriptions in this book are based on composition. However, a classification based upon the way in which minerals formed is important too because it tells an interesting story about the science of mineralogy. One such classification based on their method of formation divides minerals into "primary" and "secondary" types. Primary minerals are those which precipitate directly from a solution; for example, sugar crystals from a solution of sugar and water. Secondary minerals, on the other hand, form by a change from another mineral. Iron oxide stain, which is largely hematite, is an example of a secondary mineral because it formed from magnetite by a process called "oxidation." A primary mineral can be further classified according to the temperature at which it formed and the composition of the solution which carried the mineral-forming elements.

Other kinds of classification which are sometimes used are divided according to mineral use, such as industrial, ore, or agricultural; or according to appearance such as luster or crystal form.

The mineral and rock set provided teachers by the Pennsylvania Geological Survey does not contain samples of all of the minerals and rocks described in this booklet.

THE IDENTIFICATION OF MINERALS

The identification of minerals sometimes puzzles even the experts. Frequently special equipment or chemical tests must be used, so the beginning collector should not feel discouraged if he has trouble. However, many of the common minerals can be identified easily with the aid of a few simple tests. The most important of these are described below.

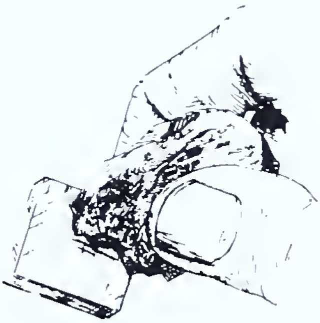
Hardness of a mineral is one of the best. A mineral is harder than another if it will scratch it. On this basis a hardness scale has been set up from one to ten, one being softest and ten being hardest. This scale is as follows, with some common minerals and materials which may be used to make the hardness test:

1.	Talc	
2.	Gypsum	Fingernail
3.	Calcite	Copper Penny
4.	Fluorite	
5.	Apatite	Steel Knife Blade
		5½-Window Glass
6.	Orthoclase	
		6½-Steel File
7.	Quartz	
8.	Topaz	
9.	Corundum	
10.	Diamond	

Color is another means of identification. Although some minerals occur in only one color, such as black for magnetite, many others occur in several colors, like quartz.

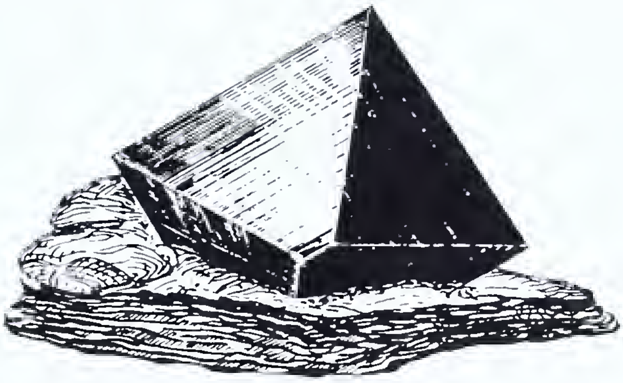
The **luster** of a mineral tells how the surface of a mineral appears in daylight.. There are two major kinds of luster, metallic and non-metallic. A metallic luster is usually brilliant and looks like a metal. Pyrite is an example. Some of the types of non-metallic luster with examples are listed below:

Earthy:	powdery	(limonite)
Vitreous:	glassy	(quartz)
Resinous:	waxy	(sphalerite)
Pearly:	irridescence similar to pearl	(zeolites)
Greasy:	as if coated with oil	(talc)
Silky:	soft and fibrous	(some gypsum, and serpentine)
Adamantine:	hard and brilliant	(diamond)



Streak is the color of the powder of a mineral. This color is often a lighter color than that of large chunks of crystals of the same mineral. The color of the powder can be most easily seen by "streaking" or scratching the mineral across the surface of a plaster tablet or plaster tile. For example chromite, which looks black, has a dark brown streak.

Crystal shape is another good means of identification. Each of the mineral descriptions in this book gives the most common crystal form.



Effervescence, or bubbling, when a drop of hydrochloric acid is added is a good test for carbonate minerals, especially calcite.

In the accompanying table, all the minerals are listed which are described in this book. By looking over this table, you will find the tests which will enable you to identify each of these minerals.

MINERAL	HARDNESS	COLOR	LUSTER	STREAK	SPECIAL PROPERTIES
Magnetite	6	Black	Metallic	Black	Attracted by a magnet
Chromite	5½	Black	Metallic	Dark brown	Not magnetic
Quartz	7	Usually white or colorless	Vitreous	none	6-sided crystals
Limonite	2-5	Yellow or Reddish brown	Vitreous to Earthy	Yellow brown	
Pyrite	6	Light yellow	Metallic	Greenish to brownish black	Often in cubes
Chalcopyrite	3½-4	Brass-yellow	Metallic	Greenish black	Found with malachite
Sphalerite	3½-4	Yellow brown to reddish brown or black	Resinous	Yellow to brown	Sulfur smell when scratched
Barite	3-3½	White	Vitreous to Earthy	White	Heavy for a white mineral
Calcite	3	White	Vitreous to Earthy	White	Bubbles in HCl acid
Malachite	3½	Green	Earthy to Silky	Greenish	Bubbles slowly in HCl acid
Feldspar	6	White to pinkish	Vitreous	White	Breaks into rectangular blocks
Clay	2-4	White to brown	Earthy	White to "dirty" white	Not in crystals
Vermiculite	2½-4	Brown or greenish brown	Greasy or Pearly	White	Expands when heated over a match
Mica	2-2½	Colorless, green, brown	Greasy or Pearly	White	In flakes
Talc	1	Colorless to green	Greasy	White	Very Soft
Epidote	6-7	Green	Vitreous	White	Hard and a characteristic pistachio green
Chlorite	2-2½	Green	Greasy or Pearly	White	In flakes like mica but more brittle

OXIDES

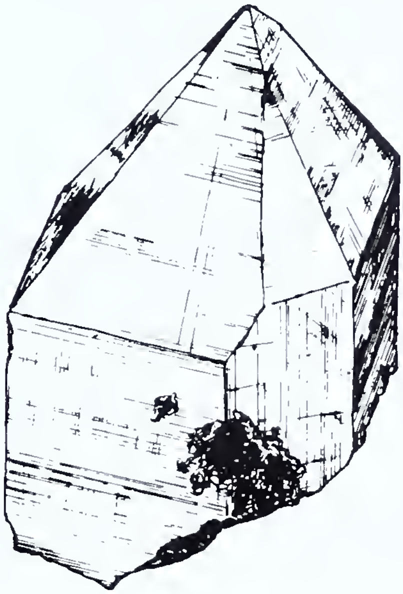
Magnetite

Magnetite (Fe_3O_4) is a relatively hard, black, magnetic ore mineral of iron. Magnetite crystallizes into double-ended pyramids, called octahedrons. The mineral is mined at Cornwall and Morgantown where it is associated with diabase and limestone. The Cornwall mine is the oldest continuously operated iron mine in the United States. As an ore of iron, magnetite is second in world-wide importance to hematite, another oxide of iron. Magnetite usually forms at relatively high temperatures from iron-rich solutions moving upward through the Earth's crust. It is found in many different kinds of rocks. Magnetite which is a natural magnet is called "lodestone".

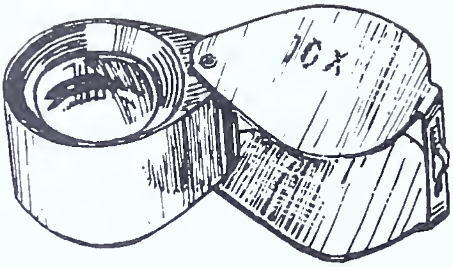
Chromite

Chromite (Fe_2CrO_4) is a black, ore mineral of chromium found in dark, basic rocks of igneous origin. Chromite usually crystallizes as irregular grains which can be distinguished from the octahedral crystals of magnetite. It often looks like magnetite, but it is not attracted by a magnet. Chromite is very dense and hard. The old mines in Lancaster County. Pennsylvania were once the world's leading source of chromium, but they are now either mined out, or of insufficient quantity to compete in today's market. Chromium is used in making chrome steel, refractory bricks, and as a coloring agent or pigment in glass and paint.

Quartz



Quartz (SiO_2), the most common of all minerals, is hard, usually colorless or white, and has a viterous luster and fracture. Quartz crystallizes in barrel-shaped (hexagonal) crystals with pointed terminations. Clear quartz is commonly called "rock crystal". Purple quartz is called amethyst and is collected as a semi-precious gemstone. Other less common colors include gray, black, brown, red, blue and green. Cornog in Chester County is a famous collecting locality for blue quartz. Quartz is the



major mineral in sandstones and quartzites, it also occurs in veins, and is a major mineral in many igneous rocks such as granite. Quartz is an ingredient in most types of glass and possesses valuable optical, electrical and heat-resistant properties. Quartz is now being made synthetically for many of these purposes.

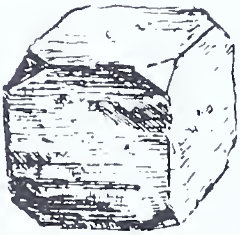
Limonite

Limonite (FeO and Fe_2O_3 with H_2O) is a yellow-brown to dark-reddish-brown, soft material which has often been used as a paint coloring agent. "Ocher" is the name applied to yellow limonite paint ores. It is of little commercial value today. Lancaster, York, and Lebanon Counties are noted for cubes of limonite which were once pyrite. These cubes are called pseudomorphs, meaning "false form." Limonite also is found in rounded concretions which are frequently mistaken for meteorites, but limonite is lighter in color, softer than a meteorite, and non-metallic.

SULFIDES

Pyrite

Pyrite (FeS_2) is a brass yellow, rather hard mineral, and is occasionally used as a source of sulphur. The yellow color of pyrite resembles gold and it is this property that has earned it the name of "fool's gold." Pyrite often crystallizes in perfect cubes and more rarely in the form of octahedrons or pyritohedrons. Pyrite was formerly used as a source both of iron and sulphur. Today it is not generally an economic mineral but in several places throughout the world it is being recovered for its sulphur plus rarer elements it sometimes contains. The pyrite at Cornwall is valuable because it contains colbalt in small amounts. Pyrite forms under many different geologic conditions and hence is present in many different kinds of rocks wherever iron and sulphur are available.



Chalcopyrite

Chalcopyrite ($CuFeS_2$) is a bronze yellow ore mineral of copper. It is often associated with pyrite but can be distinguished from pyrite by its relative softness and deeper yellow color. Chalcopyrite crystallizes in deformed four-sided pyramids called tetrahedrons. It is an ore of copper and is mined at Cornwall where it also contains trace amounts of gold. The gold is inside the chalcopyrite and is invisible to the eye. Chalcopyrite is usually found in igneous rocks.

Sphalerite — collected at the Friedensville mine, Lehigh County and near Altoona, Blair County.

Sphalerite (ZnS) is an important ore mineral of zinc. It varies in color from yellow-green, if iron-free, to ruby red and nearly black if large amounts of iron are present as impurities. Sphalerite has perfect cleavage with a distinctly resinous, shiny luster. Good crystals are rare but occasionally crystallize as tetrahedrons and less commonly as cubes. The mineral is relatively soft, about the same hardness as calcite. The mine at Friedensville is one of the largest zinc mines in the eastern United States. Sphalerite is formed from low temperature, sulfur-rich solutions.

SULFATES

Barite — collected in Fulton County.

Barite ($BaSO_4$) is an ore mineral of barium. It is a heavy, generally white-colored mineral. It resembles feldspar but is heavier and does not cleave into rectangularly shaped faces. The mineral is used as a heavy mud in well-drilling operations. Barite is formed both from heated solutions and by evaporation similar to salt formation.

CARBONATES

Calcite — collected at the French Creek mine, Chester County and Showalter's Quarry, Blue Ball, Lancaster County.

Calcite ($CaCO_3$) is a fairly soft, usually white-colored mineral of widespread occurrence. Some varieties fluoresce pink and orange. Calcite cleaves into distorted rectangular faces called rhombohedrons. Where it occurs in sufficient quantities it is quarried for agricultural lime, chemical lime, and for use in the manufacture of cement. Clear calcite is used as a prism in optical instruments. It is the major mineral in limestone and marble. Calcite forms from relatively cool solutions; for example, from ground water. Stalactites in caves are either calcite, or another form of calcium carbonate called aragonite.

Malachite — collected from the Cornwall iron mine, Lebanon County.

Malachite (a hydrous carbonate of copper) is a soft, green mineral. Usually it is a powdery coating, but may also be found in needle-like crystals. It is often found associated with azurite, which is a blue copper carbonate. Both minerals are secondary because they form from the alteration of other copper minerals. Although the malachite in Pennsylvania has no economic value, it is cut and polished into a semi-precious gem stone in some parts of the world where it is found in massive chunks.

SILICATES

Feldspar

Feldspar is a complex group of minerals containing sodium, calcium, potassium, aluminum, silicon, and oxygen. The minerals are nearly as hard as quartz and vary in color from white through gray to green and pink. Feldspar forms distorted rectangular faces when broken along cleavage planes. Good crystals are rare. It is used in the manufacture of glass, porcelain, soaps, and scouring powders. Certain varieties are valuable as semi-precious gemstones. Moonstone and sunstone are the two most popular gemstones. Feldspar is a relatively common mineral which is found in all three of the major rock types, although it is most abundant in igneous rocks formed at moderately high temperatures.

Clay

Clay is a general term for a complex group of minerals containing aluminum, silicon, oxygen, hydrogen, and minor amounts of calcium, potassium, and magnesium. Most of the clay in Pennsylvania is the variety known as kaolinite. The clay minerals usually form as secondary minerals by the alternation of other minerals, chiefly feldspar. They are soft and powdery and range in color from white to reddish brown. Clays are found in all major rock types but are most abundant in shales, in certain limestones, and below coal beds. Clay is used in chinaware, porcelain, ceramic, and brick manufacture. The clays which occur under coals are called "fire clays" and are used commonly for refractory brick. These clays at .times are hard and flinty and are called "flint clay," a type of clay especially suited for high temperature refractory brick. It will not become soft

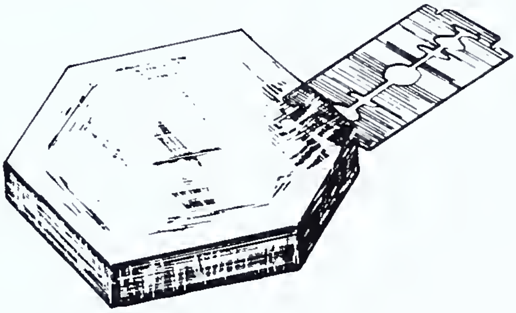
when wet. Common clay or "plastic clay" found in most parts of the state is used in the manufacture of house brick, pottery, and tile.

Vermiculite

Vermiculite is a name for a group of related minerals which may easily be confused with mica and chlorite minerals. Vermiculites contain magnesium, iron, aluminum, silicon, water, and sometimes potassium. Like the micas, they occur in single cleavage flakes or "books" of many flakes. The color of vermiculite is usually brown or greenish brown. The one characteristic which distinguishes it from the mica minerals is that it expands when heated; an ordinary safety match will cause vermiculite to swell up to many times its normal size. Because of this swelling property vermiculite is widely used for home insulation. The mineral is formed by the alteration of biotite mica in mica-rich igneous rocks. In Pennsylvania it is most abundant at Brinton Quarry, just south of West Chester. It is also found in Lancaster County and in many soils throughout the state.

Mica

Mica is a general term for a group of minerals containing potassium, iron, silicon, aluminum, oxygen and hydrogen. These minerals are characterized by platy cleavage which accounts for their occurrence as thin, flexible sheets when well crystallized. Their color is generally white, yellow-brown or green. Mica is the characteristic mineral of the metamorphic rock called schist, but it also occurs in sedimentary and igneous rocks in association with quartz and feldspar. The nearly colorless variety of muscovite is used as an electrical insulator.



Talc

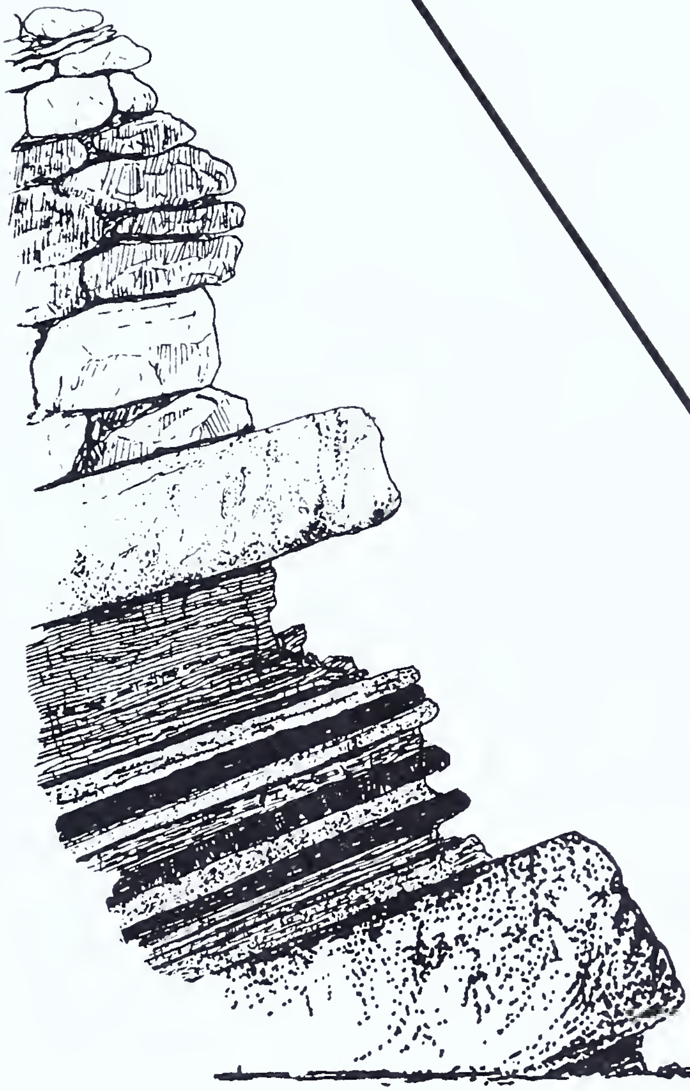
Talc (hydrous magnesium silicate) is a very soft, white to light green mineral. It usually occurs in mica-like flakes or soft foliated masses. It is commonly found associated with serpentine or as a talc schist near serpentinite. Talc is used in the manufacture of talcum powders, in talc pencils, and for laboratory equipment because of its chemically resistant properties. Talc is the softest common mineral and can be scratched with a fingernail.

Epidote — is a pistachio green hydrous silicate of calcium and iron. It usually occurs as long blades or needles often associated with quartz and chlorite. It is a hard mineral (6 to 7 on the hardness scale). When it is transparent it is used as a gem mineral. Epidote occurs primarily in metamorphic rocks and is found in many localities in southeastern Pennsylvania.

Chlorite

Chlorite (a hydrous iron magnesium aluminum silicate) is a general term used to describe a group of minerals closely related to the micas. Chlorite is translucent in thin flakes and has a characteristic grass-green to blackish-green color. The cleavage flakes are less elastic than mica flakes. It has a greenish streak and may sometimes be scratched with a fingernail. This mineral may have a greasy feel but it is not as greasy as talc. Chlorite has perfect cleavage in one direction and is easily split into thin plates. It is a common rock-forming mineral and is found as thin platy masses and as coatings on other minerals and rocks. Chlorite occurs in many metamorphic and igneous rocks of southeastern Pennsylvania and is the principal mineral of many of the schists of this area. It is not an economic mineral.

ROCKS



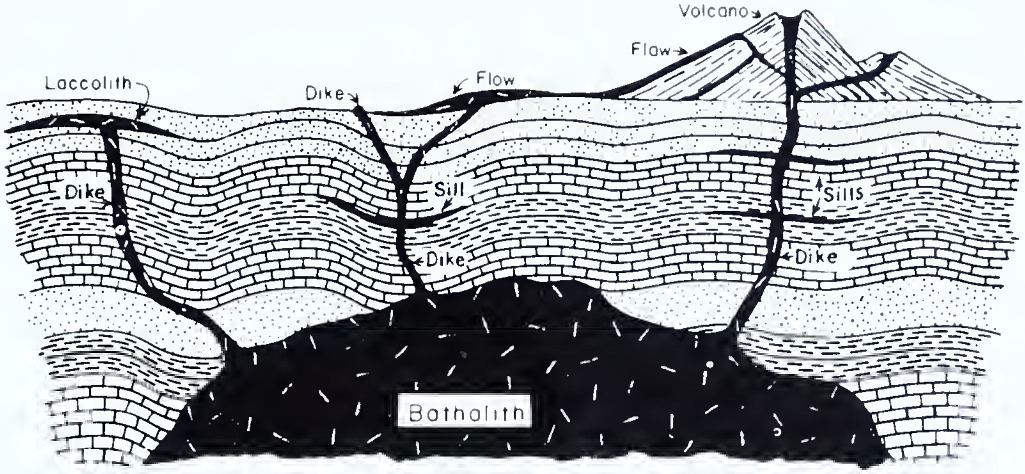
A **ROCK** is a physical mixture of minerals present in varying amounts. A few rocks contain only one major mineral. Limestone, composed largely of calcite, is a good example. Rocks are distinguished from one another by their texture and the amounts and kinds of minerals they contain. Texture refers to the size of individual grains or crystals of a mineral and to the arrangement of one mineral grain with respect to another. Color variation in rocks is in part due to the amount of silica present; for example, granite (a light colored rock) usually contains a large amount of silica. Hematite, the red oxide of iron, is another important coloring agent because it causes the red color of sedimentary rocks.

There are three general classes of rocks grouped on the basis of their manner of formation. They are sedimentary, metamorphic, and igneous. The distribution of these rock classes in Pennsylvania is shown on the accompanying maps.

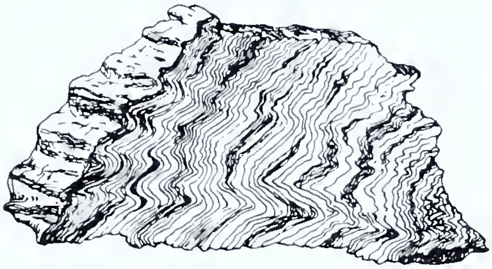
Sedimentary rocks form from muds and sands which settle out of bodies of water and are later compressed and hardened into rock. If the material is washed into the ocean basin by a river, it is said to be detrital material. If it forms by chemical precipitation or by evaporation, it is said to be a precipitate. Most rocks found near the surface of the earth are sedimentary rocks. Only sedimentary rocks contain fossils. The horizontal planes in sedimentary rocks are called "bedding planes". They are characteristic of sedimentary rocks and are caused by changes in composition or rate of piling-up of the sea muds. If the rocks become folded, these planes will be folded also.

Igneous rocks form from the cooling and solidification of hot solutions which came from below the earth's surface. These hot solutions are called magma. If the rocks cooled within the earth, they are called intrusive rocks. Granite is an example. If they are spilled out onto the surface, they are called extrusive rocks, or lava. Of the three major types of rocks, igneous rocks are least common at the surface, but become more abundant with depth. Most metal deposits are found in or near igneous rocks.

Igneous rocks with a high silica content are called "acidic" and those with a relatively low silica content are called "basic". The basic rocks are less common near the surface of the earth, but become the major rock type ten or fifteen miles below the surface.



Metamorphic rocks form by the application of heat and pressure to other rocks. This changes the form and appearance of the minerals in the earlier rock types. This change is called "recrystallization". Thus metamorphic rocks can form from both sedimentary and igneous rocks. Most metamorphic rocks have been formed during periods in the earth's history when mountains were formed because these were times when rocks were under great pressures. Thus most metamorphic rocks are bent, or "folded", by this pressure. Small fractures, called "cleavage", result from this pressure and are the characteristic feature of metamorphic rocks.



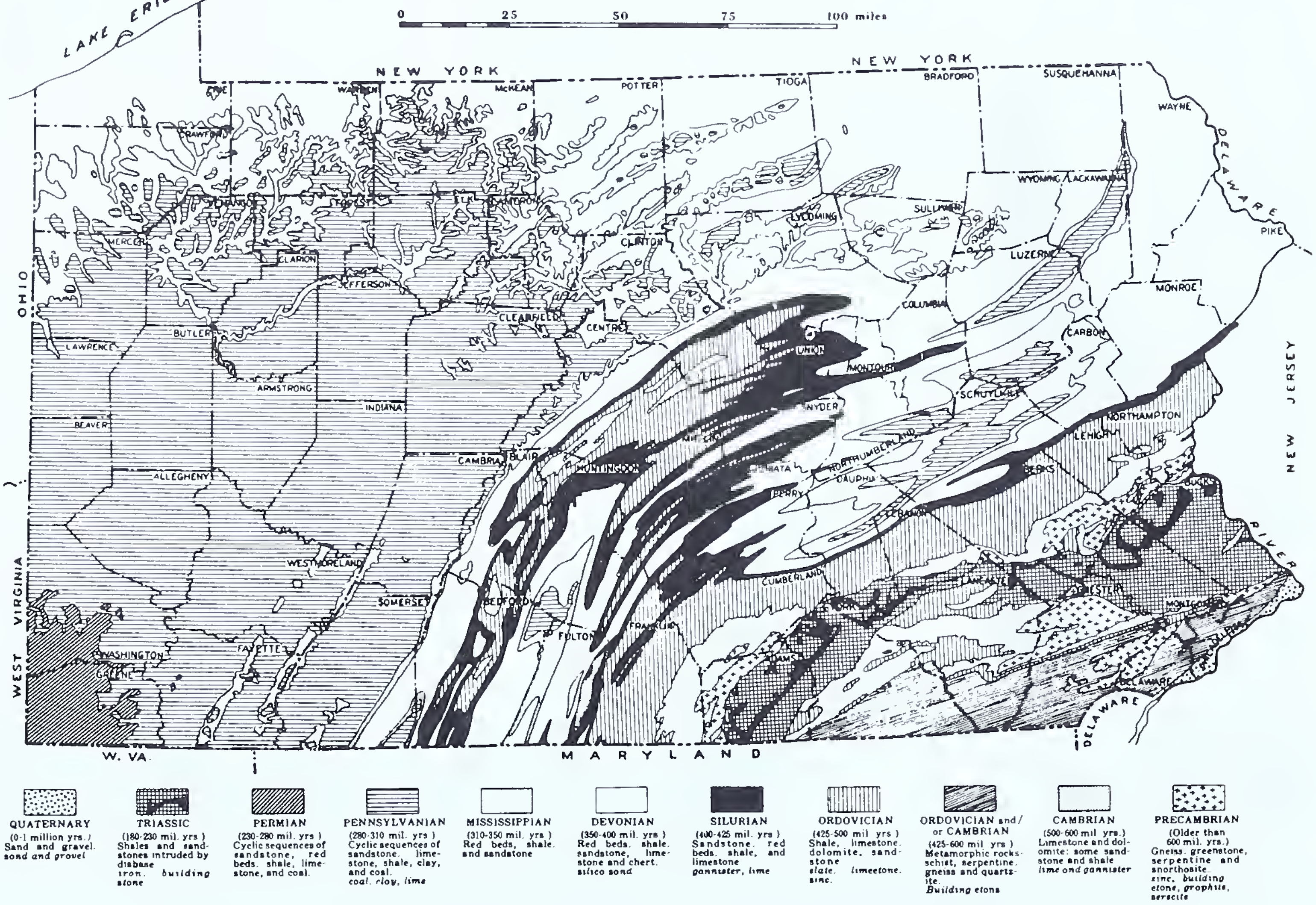
THE IDENTIFICATION OF ROCKS

The identification of rock types is more complicated than the identification of minerals. Not only must the individual minerals in a rock be identified, but an estimate must be made of the amounts of each different mineral. The grain size of the minerals is important too. However, there are some general rules which will serve as a good start in identification.

First, the rock must be placed in its correct major group of sedimentary, metamorphic, or igneous rock types. Of these three, only igneous rocks are *not* commonly layered or banded. If there is good layering, the rock is either sedimentary or metamorphic. In sedimentary rocks, the layering is broadly spaced, usually on the order of several feet or more. These layers are the bedding planes. Usually there is no particular relation between the minerals and these bedding planes. The layering in metamorphic rocks *is* a layering of minerals. Often light colored minerals alternate with bands of dark colored minerals. If micas

Geologic Map of Pennsylvania

PENNSYLVANIA GEOLOGICAL SURVEY



are present, as in schist, the mica flakes are all nearly parallel to each other. Small fractures, called "cleavage", a few tenths of an inch to several inches apart and all parallel to one another are also helpful in identifying a rock as metamorphic.

For sedimentary and igneous rocks there is a fairly simple way of dividing these big rock groups up into smaller groups. This is illustrated for the rocks described in this book by the diagrams in the tables below. The classification of metamorphic rocks depends on what the rock was before it was metamorphosed. A limestone becomes a marble. Shales become schists or gneisses depending on the temperature or pressure of metamorphism. Fine-grained mudstones become slate. Each of these metamorphic rocks will have to be learned from experience.

SEDIMENTARY ROCKS

Quartz Rich	Carbonate Rich	Carbon Rich
Conglomerate: grains 2 mm. or larger	Limestone: Calcium rich (Calcite)	Lignitic Coal dull
Sandstone: grains 0.06 to 2 mm.	To	Bituminous Coal: brighter
Shale: grains 0.06 mm. or less	Dolomite: Magnesium rich (Dolomite)	Anthracite Coal: glossy bright

IGNEOUS ROCKS

	Light Colored Quartz — Rich	To To	Dark Colored Quartz — Poor
Coarse-Grained To Fine-Grained	Granite Rhyolite (lava)		Diabase Basalt

SEDIMENTARY ROCKS

Shale

Shale contains clay minerals, quartz, feldspar, and sometimes pyrite. It breaks or parts along planes called bedding surfaces. Shale is usually brown, gray, or black and is one of the most common of the sedimentary rocks. It is a source of clay and is used in ceramic and brick manufacturing.

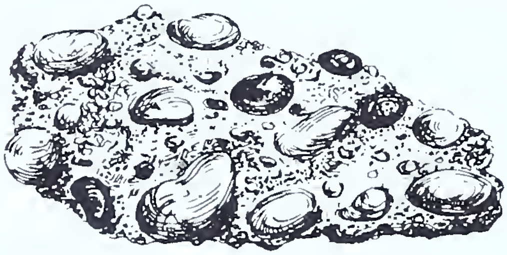
Limestone

Limestone is mostly calcite with traces of clay, dolomite, and quartz. Most commonly it varies in color from bluish white to blue-gray and almost black. Limestone is a relatively soft rock. It is quarried for chemical, metallurgical, and agricultural lime when it is relatively free from silica, iron, and aluminum impurities.

Coal

Coal is plant material which has been partly decomposed by bacterial and chemical action and then compressed. The effects of compression and heat determine whether the coal is bituminous or anthracite, the anthracite being the result of the higher pressures and temperatures. If the pressure and temperature increases beyond this, graphite begins to form. Coal is one of our important fuels.

Conglomerate



Conglomerate is made up of large to small, rounded pebbles, usually held together (cemented) by silica or calcite. A common name for this rock is "puddingstone." It formed near ancient shorelines.

Sandstone

Sandstone is composed of small quartz grains very often cemented together by silica or calcite. If the sandstone is nearly pure quartz, it can be used in the manufacture of glass. When it is pure it is white, but more often it is stained yellow, brown, or red because of the presence of iron oxides. It is a hard rock often suitable for use as a building stone.

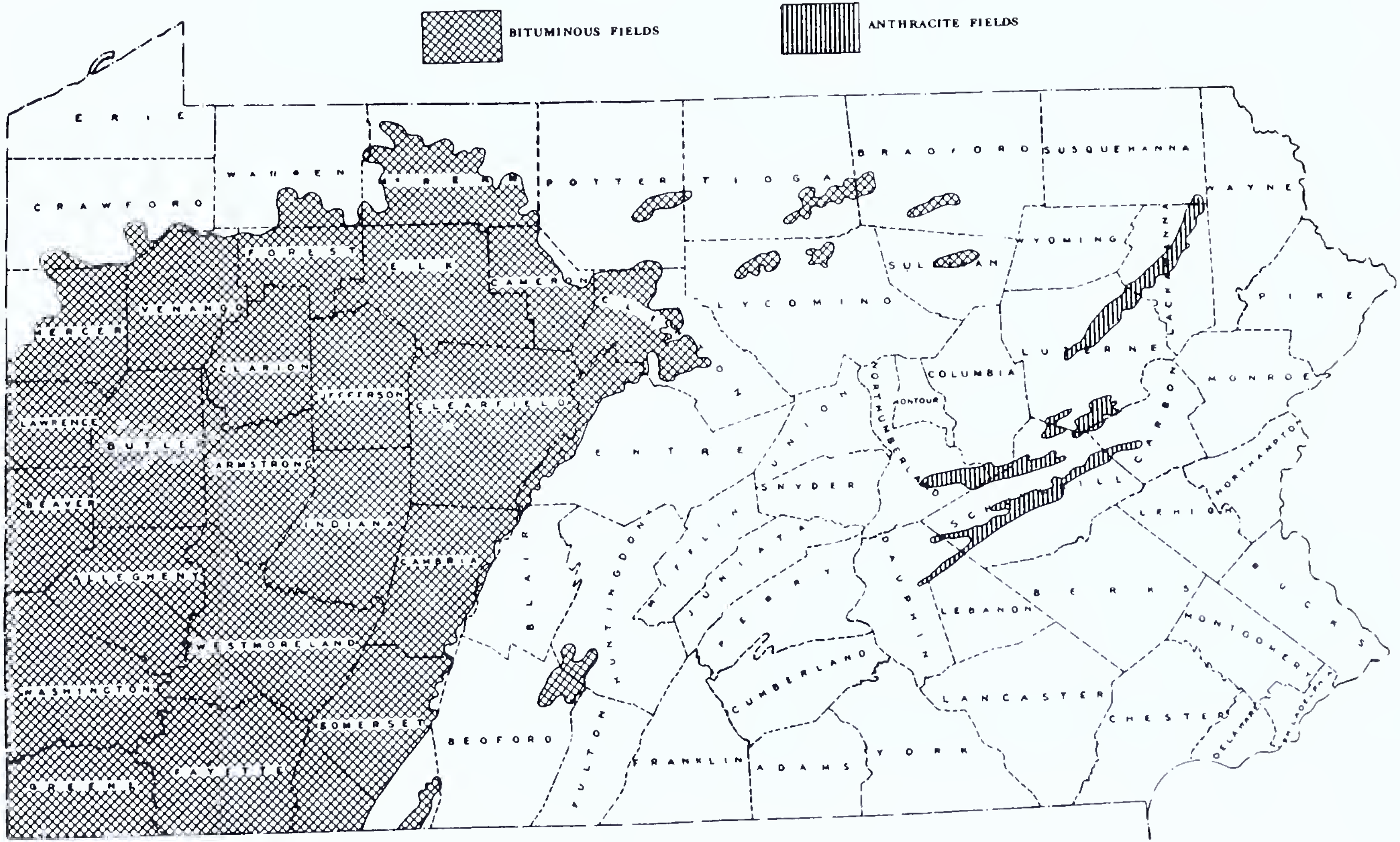
IGNEOUS ROCKS

Granite

Granite is a light-colored rock composed of quartz, feldspar, mica, and usually a little hornblende, with numerous other minor minerals. It is used as a building stone when sufficiently dense and massive. "Graphic Granite" is a mixture of quartz and feldspar which is often used as an ornamental stone. Granite is a common igneous rock, but is not as abundant in Pennsylvania as it is in many other states.

Diabase

Diabase is a dark-colored basic rock containing amphibole, feldspar, and pyroxene minerals. Diabase occurs as thin tabular bodies of rock called sheets, dikes, or sills, which have cut up-



COAL FIELDS OF PENNSYLVANIA

ward through sedimentary rocks. Many small dikes are present in southeastern Pennsylvania. Large deposits of massive diabase have been quarried for monumental stone and building stone; it may also be crushed and used as road fill or ballast. Diabase is commonly referred to as "traprock" or "ironstone."

Rhyolite and Basalt

Rhyolite, andesite and basalt are fine-grained volcanic rocks. Their individual mineral components cannot be distinguished by the naked eye except in rare instances.

Rhyolite is a light-colored, usually violet to purple, extrusive igneous rock composed of potassium-rich feldspar, high temperature forms of quartz, and a glassy matrix. It has approximately the same composition as granite. Individual feldspar crystals may be large enough to see with the naked eye.

Basalt is a black, dense, extrusive rock containing calcium-rich feldspar, pyroxenes, and amphiboles. It is the most common rock type of large lava flows. Basalt is commonly altered to epidote and chlorite. Cavities, called amygdules, are often filled with zeolite minerals. All of these rock types are relatively rare in Pennsylvania. Rhyolite is found in the western half of Adams County and basalt in small amounts near Jonestown in Lebanon County.

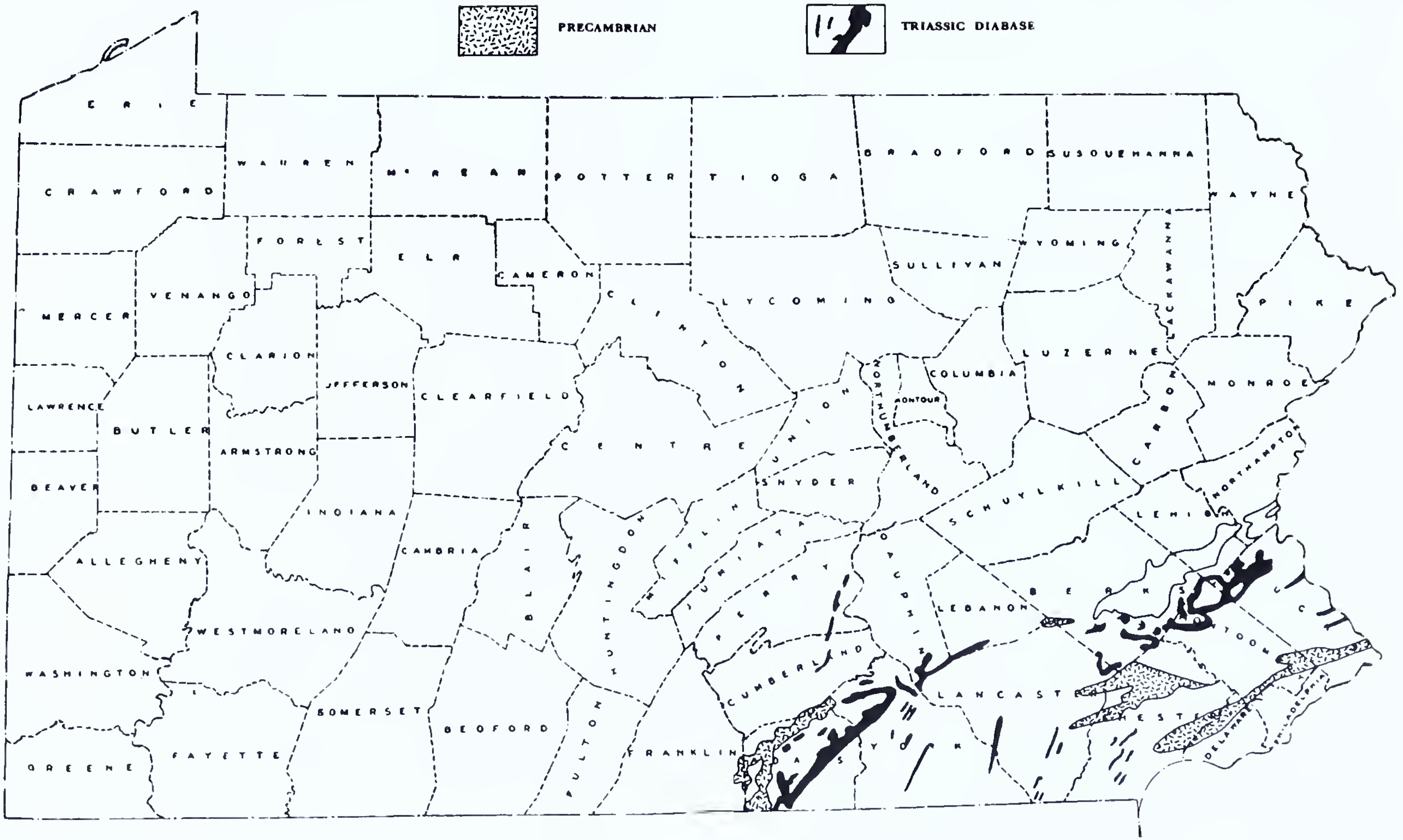
METAMORPHIC ROCKS

Marble

Marble is composed of calcite and/or dolomite that has been recrystallized during metamorphism from an original limestone or dolomite. It is a massive, coarse grained rock that often contains minor accessory minerals such as mica and chlorite which give it a streaked appearance. Individual calcite or dolomite crystal faces can be seen with the naked eye. Marble, like limestone and dolomite, bubbles when treated with cold, dilute hydrochloric acid. It is widely used as a building stone. When it contains green serpentine in large amounts, it is called verde antique, and is then an economically valuable ornamental stone.

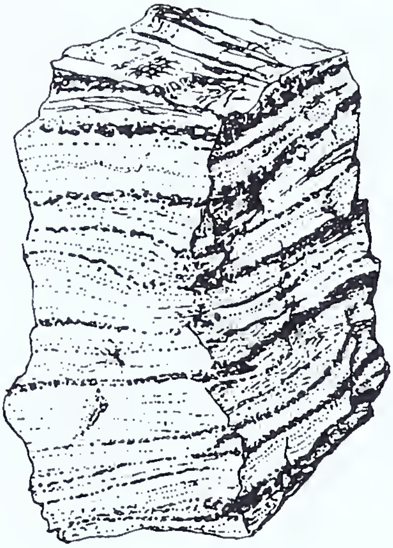
Schist

Schist is characterized by a thinly layered or foliated appearance. It has formed from the metamorphism of a shale or a sandy shale. It contains large amounts of mica, which are seen as shiny flakes along the layers. Schist may, however, contain many other minerals, especially quartz, feldspar, and garnet. It is the most common metamorphic rock in this state.



LOCATION OF IGNEOUS ROCKS

Gneiss



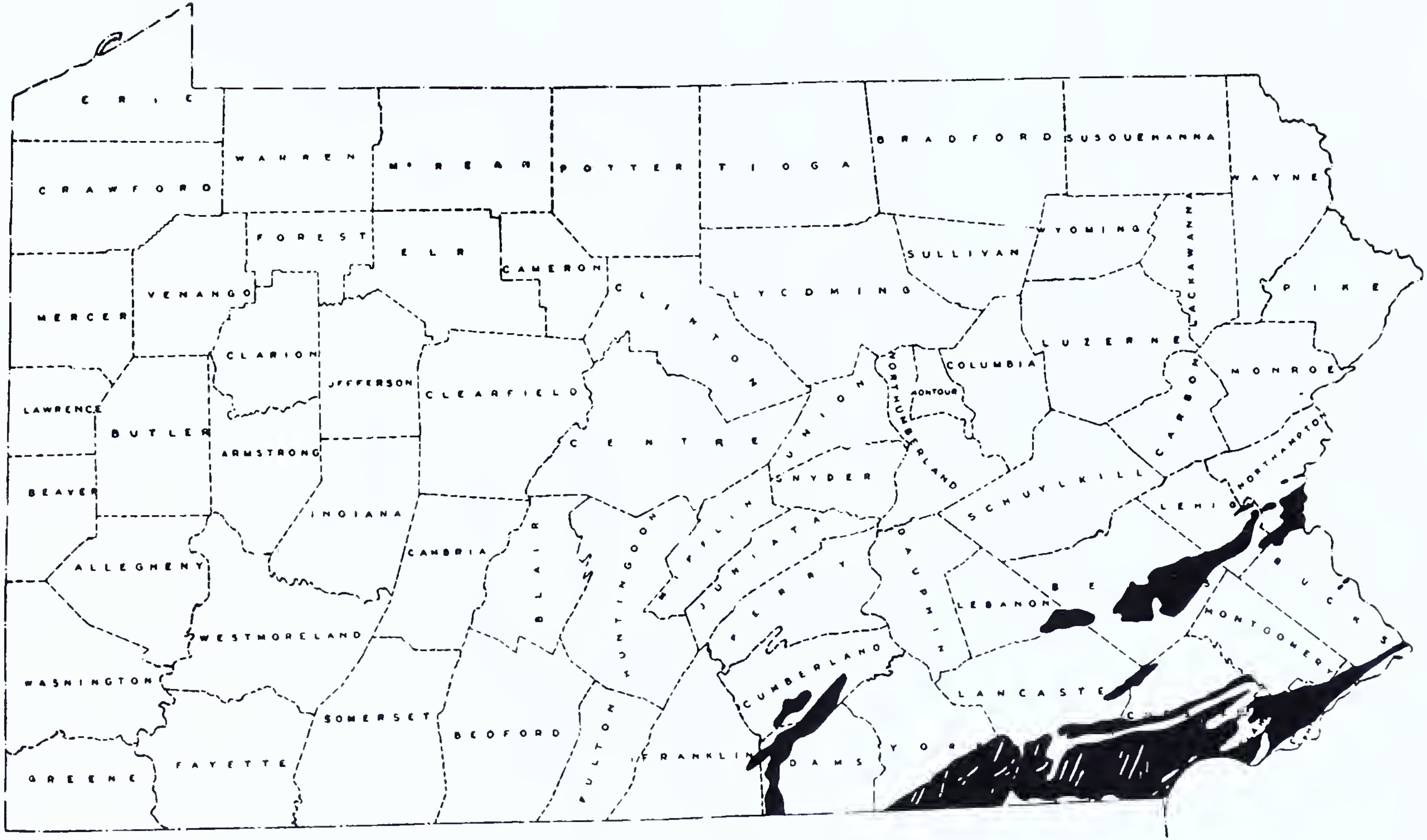
Gneiss is a banded rock usually characterized by alternating light and dark bands. The light bands are generally muscovite, quartz, or feldspar and the dark ones contain biotite or hornblende. Gneiss forms in a manner similar to schist, from shales or sandy shales, but, but under conditions of higher temperature and pressure. In addition, the chemical composition of rocks which alter to gneiss may also be different from the composition of rocks which alter to schist.

Slate

Slate is generally a gray-colored rock with smooth, thin cleavage planes. It is composed of fine-grained clays, feldspars, micas, and quartz. Slate is formed from the metamorphism of fine-grained shale or mudstone. Found in southeastern Pennsylvania in Lancaster, York, Lehigh, and Northampton Counties, it has been used for roofing slate and in the manufacture of roofing granules.

Serpentine

Serpentine is a black to green-colored rock composed of serpentine-type minerals and talc or chlorite, all of which are essentially hydrous magnesium silicates containing lesser amounts of aluminum and iron. It is often spotted with small, black grains of magnetite. Serpentine is usually soft and massive. When green in color, it may be used as a building stone, or in rare cases as a semi-precious gemstone. The gemstone name is williamsite and is one of the notable, although rare, gem-mineral occurrences in Pennsylvania. Serpentine occurs in several locations in southeastern Pennsylvania, but is not a common rock type. It has been altered from a basic, igneous rock called peridotite.



LOCATION OF METAMORPHIC ROCKS

MUSEUMS IN PENNSYLVANIA DISPLAYING ROCKS AND MINERALS

Allegheny College, Department of Geology, Meadville
Bradford County Historical Society, Court Street, Towanda
Bryn Mawr College, Mineral Museum, Department of Geology, Bryn Mawr
Carnegie Museum, 440 Forbes Street, Pittsburgh
Delaware County Institute of Science, Media
Dickinson College, Carlisle
Erie Public Museum, 356 W. 6th Street, Erie
Everhart Museum of Natural History, Science and Art, Scranton
Lafayette College, Department of Geology, Easton
Lehigh University, Department of Geology, William Hall, Bethlehem
North Museum, Franklin & Marshall College, College Avenue, Lancaster
Pennsylvania University, Mineral Collection, Department of Earth Sciences, College Hall, Philadelphia
Pennsylvania State University, College of Mineral Industries Museum, University Park
Philadelphia College of Pharmacy and Science, 43rd, Kingsessing and Woodland Avenues, Philadelphia
Philadelphia Academy of Science, 19th and The Parkway, Philadelphia
Pittsburgh University, Department of Geology, Pittsburgh
Reading Public Museum and Art Gallery, 1101 Museum Road, Wyomissing
St. Vincent College Museum, Latrobe
Tioga Point Museum, 724 S. Main Street, Athens
Wagner Free Institute of Science, Montgomery Avenue and 17th Street, Philadelphia
Waynesburg College, Waynesburg
West Chester State College, Science Museum, Anderson Hall, West Chester
William Penn Memorial Museum, Harrisburg
Wyoming Historical & Geological Society Museum, 69 S. Franklin Street, Wilkes-Barre
York County Historical Society, 225 East Market Street, York

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